UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

E

Distr.
LIMITED

ST/ECA/NRD/E/2
15 April 1982

Original: FRENCH

ECONOMIC COMMISSION FOR AFRICA

African Regional Centre for Solar Energy -
Inaugural Meeting of the Council

Addis Ababa, Ethiopia, 12-14 May 1982

AFRICAN REGIONAL CENTRE FOR SOLAR ENERGY
(Organizational and operational aspects)

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
II.	FUNCTIONS OF THE ARCSE	3
	A. Evaluation of the profitability of the various solar applications	3
	B. Priority actions	3
	1. Better knowledge of the solar and wind energy resources	3
	2. Water problem in a large number of African countries	4
	3. Preservation of products	4
	4. Solar heating	5
	(a) Hot water supply	5
	(b) Solar cookers and kilns	5
	5. Electricity production	5
	6. Biomass and Biosynthesis	6
	7. Wind energy	7

LC/NAIROBI

Page

8. Storage of energy 7

C. Strategy for ensuring the operations of the ARCSE .. 8

1. Better appreciation of the role of renewable energies in Africa 8

2. Objective assessment of the results obtained and difficulties met and for a rapid promotion of the use of renewable energies 8

3. Elaboration of an energy strategy 9

III. ORGANIZATIONAL ASPECTS OF THE ARCSE 9

1. Organs of the ARCSE 9

2. Secretariat of the ARCSE 9

3. Administration Unit 9

4. Documentation and Information Unit.. 10

5. Energy Strategy and Co-operation Unit.. 10

6. Research and Applications Unit.. 11

(a) Solar Energy Section 11

(i) Thermodynamic sub-section 11

(ii) Photovoltaic Sub-section 13

(b) Wind Energy Section 18

(c) Biomass Energy Section 19

7. Design, Manufacturing and Maintenance Unit 20

8. Training Unit 20

IV. CONCLUSIONS 21

ANNEXES (Composition and Strength)

Annex I - Administration Unit
Annex II - Documentation and Information Unit
Annex III - Energy Strategy and Co-operation Unit
Annex IV - Research and Applications - (A) Solar Energy Section
Annex V - Research and Applications - (B) Wind Energy Section
Annex VI - Research and Applications - (C) Biomass Energy Section
Annex VII - Design, Manufacturing and Maintenance Unit
Annex VIII - Training Unit
Annex IX - Strength of the Secretariat (Summary)
Annex X - Overall Organizational Chart of the ARCSE

AFRICAN REGIONAL CENTRE FOR SOLAR ENERGY (ARCSE) - ORGANIZATIONAL AND OPERATIONAL ASPECTS

I. INTRODUCTION

Research activities and applications relating to the exploitation of solar energy and its derivatives to meet the energy requirements of some development projects in which such applications are possible and desirable, are currently being carried out in several African countries having abundant sunshine, be they or not oil producing countries, while in the case of the former the operation consists in finding the diversification in the energy sources with a view to economising their oil resources.

In both types of countries, despite the encouraging results achieved, they are still far from securing the necessary facilities to pursue such an undertaking so as to ultimately obtain a true development tool: inadequate technical cadres, researchers, qualified manpower and financial resources (this is the case of non oil producing countries), all these factors prevent these countries from acquiring the necessary technology in relation to their needs and targets. However, what remains is that the experience gathered in the solar technology and its impact on rural areas specially, receives a growing favourable response from governmental bodies and those financial institutions participating in development.

At the moment solar technology is undergoing a rapid development and could in a near future prove profitable. The promotion of the use of solar energy in Africa is conditioned by the fact that any project in this area should be drawn up in an endogenuous manner by applying the most suitable methods to solving the socio-cultural and economic problems. This should however not exclude the need for a wider opening to the outside world within the context of a dynamic prospect for international co-operation which would offer the opportunity to draw from the results achieved in other countries in the field of solar energy.

From all these factors emerge the need for the African countries to set up the structures for consultations so that they can better pool their efforts in the face of major difficulties for the realisation of projects using solar energy.

These difficulties are often insurmountable by each of the countries taken separately: information on results obtained elsewhere are often received by them too late, if they reach them at all; there is also the fact that the development of certain prototype solar materials take a long time due to very limited scientific and technical cadres and financial resources. These structures for consultation are therefore more than necessary if the intention is to control the indispensable parameters so as to ensure a vigorous planning in formulating development projects.

II. FUNCTIONS OF THE ARCSE

1. Facilitate a better appreciation of the role that solar energy and its derivatives play in Africa, as part of a policy of consultation in the face of the present challenge in the field of energy and the energy needs for economic and social development.

2. Assess objectively the results already obtained, the difficulties met, the obstacles to be overcome on matters relating to research, development, definition of phototypes, manufacturing and distribution of materials and equipment using solar, wind and biomethanic energies; propose new directions likely to help the rapid promotion of their use.

3. Draw up a programme of priority actions to be undertaken as part of a global energy strategy for the African countries.

4. Ensure that the exploitation of these energy sources are no longer limited only to laboratory researches and to demonstration establishments which have so far in effect constituted the initial necessary foundation, but which should now be transcended, at least for some measures whose integration into development projects is today possible and advisable. In this connection, the resources should be devoted to applied researches, transfer and adaptation of new technologies within the African context. All this presupposes the need for existence of appropriate structures for research and application of a privileged status for the researchers so as to control brain-drain.

Assist in the training of the required scientific and technical staff and the adequate integration of this staff in the development projects. Facilitate free movement of the scientists and experts between African countries. This is the price to be paid so as to acquire the expertise for the promotion of an appropriate technology.

Assist interested countries to conduct feasibility studies with the view to coming up with a sample of an industrial enterprise for the production of equipment using renewable sources of energy, capable of covering the needs of national or sub-regional markets.

5. Promote, design and manufacturing of solar systems which would meet the specific needs of the countries, taking into account local potentialities on matters of subregional market: environment and common economic characteristics, transport problem, promotion of local industries, reduction in manufacturing costs so as to resist the competition of products manufactured outside Africa.

6. Centralise information on energy problems and ensure their dissemination. To this end, the ARCSE should equip itself as early as possible, with the existing means in the field of information so as to cover a wide range of this information which today is circulating f[illegible], but which cannot play in Africa all the role that may be expected of it due to communication difficulties.

The six points outlined under the functions of the ARCSE may be backed respectively by the following considerations:

A. Evaluation of the profitability of the various solar applications

Solar energy may quickly constitute, in economic terms, the most profitable solution in the following:

- hot water supply
- village lighting
- village water supply
- pastoral water supply
- pumping irrigation (power up to 100 kw) for photovoltaic concentrating installations and up to 30 kw for photovoltaic plan collectors
- water distillation
- drying
- production of biogas: biogas is more easily accepted by the populations for cooking food.

In the case of village lighting, village and pastoral water supply and irrigation, the photovoltaic system is the most promising especially when it is combined with the concentrating system.

- If the site is suitably selected, (really favourable regions) the wind energy can be competitive in relation to the solar energy.

B. Priority actions

1. Better knowledge of the solar and wind energy resources

Measures on the solar radiation and the characteristics of the wind have been effected in some African centres. Various measuring devices are used and there is no correlation in the measurements taken at that level. A centralisation of the data would be of great service to planners and researchers in the use of renewable energies. Such a centralization exists in the World Meteorological Organization, but the exchanges of information among African countries would make things quicker if they were organised within our continent. The establishment of a solar documentation and information centre in co-operation with national and international centres is essential.

2. Water problem in a great number of African countries

Pumping irrigation: Before any action it is necessary to conduct a study on sites to determine where the solar installations should be located and assess the quantity of water to be pumped out for each site as well as the power of the installations considering the debit of the underground water and the drilling programmes. With regard to irrigation, pumping from wells is the only solution for the populations living far from water courses. It has been established that at river banks, irrigation by surface floading is less expensive than pumping irrigation. An approximate calculation per hectar irrigated under average conditions produces 450 dollar/ha in the case of pumping irrigation and 270 dollar/ha in the case of irrigation by surface floading.

An exact calculation is therefore necessary before adopting on river banks a pumping solution. An engineering office should be established within ARCSE, whose main task will be to assist each country concerned to carry out such studies, determine the performances of each solar installation and make the appropriate choice of the systems to use: wind mills, solar pumps with flat-plate collectors or photovoltaic collectors etc. in relation with diesel solution.

Solar Distillation: There is the problem of solar water distillation in coastal regions and in certain regions where the water collected from underground sources is brackish. Technically, this distillation has been resolved, but the problem of the choice of the best prototype and its manufacture in series will be necessary.

3. Preservation of products

The problem posed by the preservation of agricultural products, fish, forage and dry meat could be satisfactorily resolved with the establishment of solar dryers in the fishing areas, in agricultural countries or in cattle breeding countries. The establishment of fishermen's, farmers' and cattle breeders' co-operatives would help better plan the use of the dryers. Experiments had been conducted in some African countries and, now, it has been proved that by reducing the losses resulting from the bad preservation of foodstuffs, the income of countries and fishermen can be substantially increased.

Here also the results obtained should be better shared throughout African countries and the solar systems extended to all places where there is the problem of preservation.

The work of co-ordination which is so vital here, could be undertaken by the African Regional Centre for Solar Energy.

4. Solar heating

(a) Hot water supply for domestic and industrial use is today the most widely practiced solar application in the world. Production of water vapour using concentrating collectors was developed in several countries. This application helps to economise on fuel in the food industry and reduce dependence on the imports of petroleum rproducts and coal.

(b) Cookers and solar kilns:

The wrong utilization of fuel wood (in hearth with three stones used for cooking food, 95 per cent of the heat generated is lost) and the meagre forest resources lead to a rapid desertification of several African regions. There is therefore an urgent need for utilising all the available resources to substitute fuel wood and charcoal by other sources of energy. Attempts had been made to utilise concentrating solar cookers, but there were difficulties because of the attachment of the populations to the traditional methods of using fuel wood for cooking. The work should be pursued in co-operation with organizations concerned with human progress.

Several applications are currently underway in order to produce more profitable cooking hearths. Today, it is necessary to conduct an investigation on the results achieved and the difficulties encountered. The African Regional Centre for Solar Energy can play a vital role by encouraging a wide popularization of the results of such an investigation likely to affect a large population possible. This means placing at the disposal of the population, simple, operational and less costly systems which they can themselves manufacture and maintain.

With regard to solar kilns, the present phase should involve gathering maximum information on the results obtained in the industrialized countries before starting the applications which are profitable only for specific uses and processing of expensive materials.

5. Electricity production

Systems of electricity production based on the use of photovoltaic collectors (with or without concentration), flat-plate collectors with selective surface and wind mills, have been developed in some African countries and even at times taken over by national electricity boards which, together with the centres for research and applications, study their profitability and the parameters to be controlled in relation to the African environment. The electricity thus produced is especially used in the rural areas, in centres distant from urban areas, for which the cost of transporting fuel for the running of the diesel engines become prohivitive. This electricity can serve not only to light houses but also make more operative the mass education and health

education campaigns in the rural areas: it is worth mentioning here the experiments currently being made in several African countries on solar television. This is a problem which deserves great attention because the advent in rural areas of electricity produced from conventional methods (utilization of petroleum products or coal, conveyance through electric lines) in most cases is far from implementation. The operation should be sustained even if it is considered by economists as unprofitable. What is at stake is whether the rural communities should continue to bear the costs each time an operation is declared unprofitable. Then when will their living conditions begin to improve?

A solution may be found to the problemf of telecommunications and air conditioning through the use of solar electricity. A few experiments are underway and, here, it is indispensable to co-ordinate efforts. Although these problems are attractive for the future, they do not today appear as a top priority and the resources required are relatively high vis-a-vis the possibilities of the countries concerned. With regard to telecommunications, there is the need for an international action under the auspices of an institution such as the African Regional Centre for Solar Energy.

The refrigeration should be considered as part of the preservation of pharmaceutical products and food stuff. The refrigeration by means of cooling cycles by absorption appears technically possible. This is the most urgent problem to be resolved in the search for improving the health of the populations. The air conditioning of houses so as to make them a bit cool, would succeed if it is based on the development of the architecture known as "Solar" using the traditional architecture which for the populations has constituted some sort of rampart against the severe effects of the sun.

Today, it is necessary to conduct investigations into the traditional architecture and gather the results of the ongoing researches. Improvements made could serve as a guide in the construction of modern houses with the energy requirements which should be met to make it functional.

6. Biomass and Biosynthesis

The biomass offers enormous possibilities for obtaining methane and fertilizers through anaerobic fermentation. Inventory should be conducted in the countries or in the subregion so as to assess its energy potential. In preparing the estimates, account should be taken of the nature of the agricultural wastes, because it has been noticed that the quantity of methane produced varied significantly according to the type of the waste. The biomass can also be used for the production of liquid fuel as partial substitute for petrol. The experience of Brazil in the production of large scale ethanol is a good illustration.

This energy potential is very important in Africa and could help if rationally exploited, to reduce significantly the effects of energy crisis for a great number of countries.

Biosynthesis on the other hand is a process whereby solar energy is utilised indirectly to produce abundant food for cattle and even additional food for human consumption. According to some recent information, microorganisms had been discovered through which large quantities of proteins can be obtained for feeding cattle from water, sun and little quantities of carbon dioxide within a relatively short time.

Considering the food crisis faced by cattle in Africa and which constitutes a major impediment to its development, this process is of a great interest. In the face of the draught affecting several African regions, it will undoubtedly constitute supplementary solution for the mechanised pumping of water for the survival and growth of the cattle.

7. Wind energy

In the African regions where the winds blow at high speed, the wind energy could within a short period of time, become competitive for some applications and quite earlier than photovoltaic energy.

For some years the Savonius type of wind mills were being used for pumping. They can easily be constructed and even those made by cottage industries can be of great service in village farms. Their maintenance which does not require major technical specialisation and material resources is a favourable justification for them to be popularised in the rural areas.

For the electrification of secondary centres, the researches and applications are focused on the development of wind power generators with a capacity of 50 to 100 kw to be operated alternately with conventional diesel electric generators.

8. Storage of energy

The new sources of energy mostly operate intermittently (i.e. solar radiation, wind energy). It is therefore necessary to store the energy produced if it is to be better exploited.

The problem to be solved today is how to succeed in storing large quantities of energy in a form that can be easily utilised and at a reduced cost.

The following two forms of storage appear attractive for use in the future in developing countries:

- storage in chemical form in plants after photosynthesis. This natural storage is not expensive and the channels using it are likely to benefit a great deal;

- storage in the form of potential mechanical energy by pumping water in a reservoir situated at a high altitude. This procedure interests a number of industrialised countries.

C. Strategy for ensuring the operations of the ARCSE

1. Better appreciation of the role of renewable energies in Africa

The various technologies being developed regarding the utilisation of new sources of energy have not yet brought out miracle/solution for the developing countries. Here three infallible criteria should serve as a guide in making any choice: Here is first of all the criteria of renewable energies available, then the criteria of existing energy requirements and finally a thorough knowledge of the objectives to be attained.

2. Objective assessment of the results achieved and the difficulties met and for a rapid promotion of the use of renewable energies

A comprehensive study should be undertaken as part of a mission throughout Africa so as to ascertain on the spot the precise pre-occupations of countries regarding solar technology. This will enable the African Regional Centre for Solar Energy to have a more global view of the situation so as to better determine its actions and assistance as follows:

- establish a data bank on the applications of solar energy and its derivatives;

- assist the members States of the African Solar Energy Centre to promote and appropriate solar technology through a better dissemination of information on the advantages of solar applications by organising study tours, symposi, seminars, meetings, exhibitions of equipment and films, trade fairs and demonstrations;

- draw the attention of the member States to the need for a development plan taking into account the possibilities existing in the use of solar energy in particular and renewable energy in general;

- promote solar applications in the member States by contributing to the strengthening of the existing research centres and creating new centres in the countries where the potential exists in the field of renewable energies and which are interested in these applications;

- encourage inter-African co-operation in particular and international co-operation in general, in the field of the utilisation of solar energy and its derivatives;

- assist in the promotion of the local manufacturing of solar equipment by local industries, which should help reduce the costs of this equipment: countries should be endowed with appropriate structures to carry out on the spot the necessary tests and experiments on the systems produced so as to make them efficient;

- encourage member States to introduce in school and university curricula the study of solar energy and its derivatives applications by clearly highlighting the prospects offered in this area for the economic and social development of African countries;

- assist in the training of engineers, technicians, researchers and qualified workers in the academic research and applications.

3. Elaboration of an energy strategy

The exploitation of solar energy must be linked to the utilisation of other sources of energy. This entails the elaboration of a global energy strategy which, in its realization, must be readjusted, taking into account the progress achieved by the solar energy applications at global level and national energy development plans.

III. ORGANIZATIONAL ASPECTS OF ARCSE

ARCSE will comprise several executive organs which should have relations with various national and international bodies dealing with energy problems.

1. Organs of the ARCSE

ARCSE organs include: The Council, the Executive Board and the Secretariat with its administrative and technical Units;

2. Secretariat of the ARCSE

The ARCSE secretariat will comprise an Executive Director, a Deputy Executive Director, a Chief Technical Advisor and Directors (Heads) of Units;

3. The Administration Unit will comprise:

(a) A Personnel Section

(b) A Finance Section

(c) A Conferences Section

(d) A General Services Section

The composition and strength of this Unit are attached to this document as Annex I.

4. Documentation and Information Unit

This Unit will co-operate with the national, subregional, regional and international documentation and information centres. During the initial phase of ARCSE project, it will have an indispensable role to play. It should provide the project with the maximum data and also meet the needs of the national centres by storing, processing and disseminating scientific, technological and, if possible commercial information. To make such a centre operational, the services of a computer engineer, three documentalists and a computer/terminal technician will be needed (Annex II).

5. The Energy Strategy and Co-operation Unit

To be able to better appreciate the role that solar energy and its derivatives, if jidiciously exploited, could play in the search for a solution to energy problems in Africa, there is the need for a global energy strategy based on national programmes and the trend of the current energy process throughout the world; such a strategy should include appropriate solar technologies, the priorities and the social, economic and geographical realities of the countries concerned. In drawing up programmes, account should be taken of the medium- and long-term problems of production and research and the structures to be laid down for that purpose.

For the running of such an office provision should be made for at least an engineer or a physicist who is specialized in solar applications and who is very conversant with energy problems in general to be able to lead a team of engineers and physicists specialized in research and applications, each in at least one of the following areas:

- solar energy proper — (1 thermodynamic expert
  (1 photovoltaic expert
- biomethane/biosynthesis energy
- wind energy

In addition to these scientists, provision should also be made for an economist who is quite conversant with the trend of energy problems in general and the use of renewable energy sources in particular (Annex III),

It should be emphasized that each of the scientists (engineers or physicists) could head a section corresponding to one of the areas of research and applications referred to earlier. Each of these sections must have an adequate number of technical staff to carry out under favourable conditions experiments and tests on prototypes produced in those sections. These prototypes should, in most cases, be equipments which, it should be emphasized, must be perfected in the African Regional Solar Energy Centre in view of the important resources required and/or considering the difficulties, African countries taken separately or within the same subregion, would face in carrying out successfully such projects (landlocked countries for example, difficulties of supply, means of transport).

The above sections could be grouped under the Research and Applications Unit as follows:

6. Research and Applications Unit

(a) Solar Energy Section, comprising:

(i) A Thermodynamic Sub-Section: concentrating and flat-plate collectors: their manufacture and perfecting are determined by their use in the following priority sectors: water pumping, solar heating, electricity production, demineralization of water. Before any application in a given climatic zone, an optimization of their reliability with regard to environmental effect is necessary. The tests to be carried out on the prototypes must prove that the perfected collectors are capable of resisting conditions of arid zones, for example. The climatic conditions prevailing in countries where a specific solar system is going to be installed (moisture, direct or diffused solar radiation) must be fully exploited by a judicious combination of certain equipments such as thermodynamic converters with concentrating collectors under conditions of low moisture and direct solar radiation. However, what is required is not only adapting the installations to climatic and other conditions as part of a vertical transfer of technologies but also, and more particularly, finding long term means of manufacturing these equipment locally and ensuring that they are of real use to the countries (or groups of countries) where they are to be installed, by simplifying and standardizing them. The selection of equipment should be such so that it could be integrated into local industrialization projects such as metal processing industry in developing countries which is an important factor in creating new jobs on the spot.

The studies to be carried out could focus on the output of the collectors:

- output depending on the temperature used
- output depending on the number of transparent surfaces
- output depending on the nature of the absorbing surface, the selective surface and anti-radiant structures
- output depending on the nature of the transparent surface
- output depending on the nature of the absorber.

All the tests to be carried out could be based generally on the following considerations:

- The existence of facilities at the Centre to measure such parameters as direct solar radiation, global solar radiation, diffused solar radiation, velocity of the wind and moisture. These parameters should be constantly recorded and preserved. This exercise would be beneficial if it were carried out in co-operation with national and international centres engaged in similar activities and which would contribute to the creation of a data bank;

- Emphasis on such parameters as the effect of the sand, dust, rain, and temperature on the resistance of the metals and reliability of the components in developing and manufacturing of collectors;

The stability of the selective and absorbing layers, the choice of the reflectors and their mode of fixing, the simplicity of such possible trial systems as concentrating systems, the mobility of the joints of the mechanic systems (system that makes it possible to follow up the movement of the sun, for example), the behaviour of materials under the effect of the factors of erosion, the reistance of safety and protection systems of the whole system (the quick assembling and dismantling of the whole system when the need arises), the stability and the power of the systems (solar power stations, for example), the problems of thermal losses and the output of the collectors and the simplication of the chassis of these collectors are very important elements linked to these parameters and determine the development of solar technology;

- the selection of the place where the pilot project should be set up is based on the following criteria:

  - possibility of using it for educational purposes
  - remoteness of the rural centres from the urban centres
  - possibility of servicing the systems

To these criteria should be added a series of surveys on:

- energy consumption of the urban and rural communities;
- current methods of energy supply;
- possibilities of developing agriculture, the small-scale industry as well training sectors, hygiene and public health through better energy supply;

- size of the communities;

- response of the people to new technologies;

- improvement of the living standards of the people concerned.

A good conduct of these surveys and tests determines the approach to the work in order to attain the desired objective: provision for the manufacture of components of the appropriate solar systems at the place of installation on the basis of the market potential.

(ii) Photovoltaic sub-section: Some specific laboratories carry out basic research on photocells and the possibility of manufacturing and marketing these cells in Africa looks very remote. There are on the market photocells manufactured in series in some developed countries.

The assembling of photovoltaic panels.

The problems being faced are their adaptability to climatic conditions and their assembling in Africa. Many tests are currently being conducted at research centres and in the rural areas on the applications of solar energy by supplying electricity to the centres for water pumping, lighting, solar television, telecommunications and meteorological stations.

At a centre like ARCSE, the tests referred to could be conducted with more important and sophisticated equipments than in the national research and application centres. Studies could be carried out on the resistance of panels and their optimization. For instance where pumping is required, this optimization should include such factors as the depth of the wells, the quantity of water needed, the choice of the pump to be fixed on the photovoltaic generator and the possibilities of storing the pumped water. In the tests, the possibilities of comparing photovoltaic installations with other installations like the diesel generators for example should be envisaged.

The studies to b carried out could, for information purposes, concern:

- photovoltaic installations with high concentration: behaviour depending on the climatic zones in Africa;

- photovoltaic installations with low concentration;

- problems with regard to the interconnexion of photocells and the behaviour of the systems;

- the system of converting photovoltaic current into an alternative current.

The photovoltaic channel is also promising in as much as it is possible to forecast technological development and the cost of the cells both for the flat-plate panels and the concentration systems of this channel.

With regard to the flat-plate panels referred to earlier, the electric current obtained is directly used by a continuous electric current motor to which a pump could be fixed, to use only this example, which is very vital to a great number of African countries. Maintenance is therefore reduced to minimum.

Regarding the concentrating photovoltaic installations, it should be emphasized that they could lead to the immediate reduction in the cost of electricity, not to mention reduction in the cost of the cells.

Substantial results of the experiment on the location of such systems, as far as African countries are concerned, are yet to be obtained.

The African Regional Centre for Solar Energy could co-ordinate actions in this direction by ensuring that its Research and Applications Unit undertakes development work on some carefully selected prototypes while at the same time encouraging the organization of popularization campaigns in the countries where the installation of such systems is desirable and possible.

To the promotion of the manufacture of solar collectors, apart from pumping and electricity production, should be associated also such important uses as:

-- solar drying for the preservation through desiccation of foodstuffs and forage. Most of the African countries are agricultural countries and it is more than imperative for them to be able to preserve their agricultural products.

In many of these countries, these prototypes of solar dryers have been produced and tested ever since. ARCSE could play a very important role here by taking stock of these prototypes and circulating information on them among the African countries while safeguarding their industrial property aspect. The centre could work out guidelines and manufacturing designs for the member States; it could propose choices after assessing on the spot their needs and resources and could conduct required tests which a country or groups of countries concerned are not capable of carrying out.

These drying techniques make it possible to improve productivity compared to the traditional way of exposing foodstuffs directly on fences (or on the ground) to the sun with its concomittant considerable losses (40 to 60%) due to infestation by insects.

Already the experiment carried out on these prototypes have made it possible to test:

- various types of solar flat-plate collectors for the production of hot air;
- drying areas of various types: tunnels, linen cupboards;
- various types of fences;
- various building materials (wood, cement) and thermal insulation (groundnut husks, fibre-glass, polyurethan.....)
- natural ventilation (simple, solar chimney) and artificial ventillation;

All this has made it possible to make some technological choices. All these experiments could be made more efficiently and lead to more satisfactory results by a centre having adequate research and applications structures and number of highly qualified scientific and technical staff, which is seldom the case in African national centres.

The most common utilization of these dryers is focussed on the drying of agricultural products, fish (villages and fishermen co-operatives), meat and forage and, at present this mainly concerns drying tents that are cheap and easy to build, with a modular device for possible extension. Local or locally produced materials should be used in putting up the building.

This will mean working out a compromose between the question of performance and the imperatives of local feasibility.

Some guidelines could be worked out in preparing a research programme to be carried out at ARCSE which should develop some prototypes in order to collect enough information on:

- the optimization of drying systems;
- the use of artificial ventillation by a photovoltaic power generator;
- the improvement of the distribution of hot air;

The following may be dried:

- cereals (rice, maize etc...)
- fish and meat;
- oleaginous crops (groundnuts);

- vegetables (acro, paper, tomatoes, etc....);

- forage;

- coffee, cocoa, etc.....

Solar water heater: Provision of domestic and industrial hot water.

The provision of domestic and industrial hot water is widely practiced and solar water heaters started to being marketed in some African countries. In view of the high prices of imported water heaters (even the solar heaters), it is more than ever necessary to envisage producing them locally by using local materials as much as possible. It is possible to use them in several ways: domestic and collective use (hospitals, dispensaries, hotels, schools) or for industrial use. In each of the countries concerned it is possible to assess their marketing potential on the basis of the following data:

- the number of electric water heaters imported annually;

- building market (houses, block of flats, etc....);

- industrial projects requiring the production of hot water (food industries, textile industries);

ARCSE should encourage countries to address themselves to these problems, for with the use of solar water heaters it is possible to save foreign exchange by cutting down on the importation of the fuel consumed by diesel engines for example, not to mention the cost involved in the importation of lubricants (oil) and materials for the production of electricity.

Refrigeration/air conditioning

In Africa, there is a great demand for cold storage facilities, big or small (from domestic refrigerators to industrial cold stores). Researches carried out in this respect require overly expensive resources and this impedes in the developing countries the production of cold which is nevertheless vital for many economic activities. Here we are faced with an area of application where very few African countries taken separately can effectively conduct experiments and tests. ARCSE could take part in these actions so as to develop prototypes in the co-operation with national or international research and applications institutions which have some experience in the production of solar refrigerating machines (absorption machines for example) and perhaps even in refrigeration (cold stores).

...

With regard to solar architecture and air conditioning, the problem consists first and foremost in protecting the house against insolation and sand wind by playing on the nature of the roof, its direction, the thickness of the walls, the nature of the building materials, the position of doors and windows, the ventilation of the rooms etc....

A survey should be dconducted in African villages on traditional architecture in the rural areas before effecting any modifications, if we want to avoid an open radical interference with the socio-cultural values of the people concerned.

As for solar air conditioning, it is still at the xexperimental stage even in the developed countries. The progress made should be followed even if this technique is still very costly compared to the conventional systems of air conditioning.

Solar distillation

The areas of research to be developed concerns the use of solar energy to process brackish water. Many prototypes of solar stills were produced in a great number of research centres in Africa.

In this connection, ARCSE could initiate major projects for the production of drinking water through desalination of sea water or brackish water.

Solar cooker

The use of these cookers with concentrating captors are yet to be patronized. This is because they interfere with the African traditional way of wcoking; however, they can render great services in the cooking of food and the production of hot water, thereby resolving the problem of sterilization in dispensaries located in remote villages (firewood has to be fetched at several kilimeters from the village and more often than not these villages have neither gas nor electricity).

It should be emphasized that the use of the solar-cookers combined with that of auto-cookers (for example clay cookers using wood) makes it possible to successfully do different cookings at the same time (for example cooking rice on one side, fish or meat on the other side). However, before studying the cooking conditions and methods, there is the need first and foremost to think of putting up the structure to be used as kitchen which, well planned and constructed entirely with local raw materials and by local artisans, is the essential factor for the success of the integration of solar fuel in the cooking techniques of the African housewife.

In their control of deforestation, many African countries, from among those mostly concerned, could find here a valuable helper. It is worth recalling at this juncture that cooking food in the open air or in the hut during the raining season leads to heat losses, therefore of fuel (wood in our case) which vary from 60 to 85%. To the African rural housewife who has great difficulties in fetching firewood, who is compelled to trek long distances in search for firewood which is becoming scarce, the use of solar cooker would be a source of great relief. As for the urban housewife, she would notice a reduction in the expenses involved in the purchase of charcoal which are becoming increasingly cumbersome and unbearable for the moderate family budgets. However, it should be acknowledged that there can be no simple solution or solution that does not necessitate a gradual change of habits or cooking traditions.

With the help of the organizations concerned with the promotion of human conditions in general and women's conditions in particular, studies on all aspects (economic, social and cultural) should be conducted and the training of housewives guaranteed. ARCSE could find here a ground suitable for its action of information, training and encouragement and the popularization of self-reliant techniques.

The actions of the Centre must also be focussed on the promotion of a local industry of improved cookers.

The Solar Energy Section will have a Chief of Section who will co-ordinate the research-development activities, industrial applications, social acceptance and the amanufacture/trial of prototypes or pre-series in the thermodynamic and photovoltaic fields. The composition and the strength of the section are attached to this report as Annex IV.

(b) Wind Energy Section

The following are the main parameters to be borne in mind in the promotion of the use of wind energy in Africa:

- Assessment of wind energy potential in African countries. Efforts should be made to ensure that the measures to be taken cover as many countries as possible through the establishment of a network of wind recording stations depending on the wind system observed in Africa.

- The data will be collected and disseminated in the form of publications at the regional level.

- The life span of the equipments.

- The windmills used in Africa (practically to this day) for pumping purposes have not been very satisfactory. A study into the conditions of an effective and economical use is currently being carried out in several research centres in Africa. This study will be sponsored by ARCSE.

The Wind Energy Section will have a Chief of Section who will co-ordinate the research-development activities and the experiment on and manufacture/trial of prototypes.

The composition and strength of the Section are attached to this document as Annex V.

(c) Biomass Energy Section

The energy conversion of plants in the form of waste (bagasse, husks, straw) or of crops specifically meant for that purpose offers great possibilities in Africa as follows:

- Direct burning

- Methane fermentation

- Pyrolisis or gasification

Unlike the other systems of conversion, the energy converted can be stored easily.

Investment is relatively reduced compared to other sources of energy, under comparable powers.

The output applies to the whole period of radiation and not to some few hours of most intensive radiation (thermodynamic systems).

The use of methane gas produced through fermentation (either from plant waste or from animal dung) is at present the way which seems to be best accepted by the African people, particularly for cooking food. Digester prototypes are produced and a more extnesive education and dissemination campaign is necessary to ensure their widespread use in the rural areas. The preliminary research currently being made in Africa must be pursued to make the system more operational and to prove that they can result in appreciable savings on imported petroleum products or fuelwood.

The Biomass Energy Section will have a Chief of Section who will co-ordinate research and development activities, studies and experiment on and manufacture/trial of prototypes in the fields of methanization, gasification-pyrolisis and the improvement of combustion.

The composition and strength of the Section are attached to this report as Annex VI.

ARCSE should be equipped with wind velocity and sun radiation automatic recording stations. It should participate actively in the assessment of solar and wind potential in Africa.

A computation centre should necessarily form part of the equipment to handle radiometric data and exchange them with the various national and international centres with the help of a modern computer. All this requires the establishment of a manufacture and maintenance electronic and electrotechnical laboratory within the solar energy section.

7. Design, Manufacturing and Maintenance Unit

This unit will have a design section and a section with three workshops (solar, wind and biomass) which will be responsible for the manufacture of prototypes of solar, wind and biomass equipments; it will also be responsible for the assembling of equipment, maintenance and for conducting tests.

The Design, Manufacturing and Maintenance Unit will be headed by a Chief of Unit who will co-ordinate the activities of the three groups of technicians (workshops) in the fields of solar, wind and biomass energy; he will also co-ordinate the design and maintenance activities.

The composition and the strength of this Unit are attached to this report as Annex VII.

The team responsible for transport and the maintenance of vehicles will be under this Unit. It will comprise 6 drivers and two mechanics.

8. Training Unit

The role of this Unit is of vital importance in that through it, the African Regional Centre for Solar Energy should support the activities of countries regarding the training of their technical and scientific staff.

Such a training will be contemplated for engineers who have specialized in the following fields:

- Thermodynamics
- Photovoltaics
- Energy strategy
- Marketing and management
- Wind energy
- Biomass and biosynthesis

It will also be contemplated for in-depth applied research studies (at the level of engineers and doctors for instance).

In all cases, assistance to African countries could include training fellowship offers, provision of highly qualified specialists to the countries, participation by African technicians, engineers and scientists in experiments and tests conducted by ARCSE. To be effective, this assistance should be backed by the free movement in Africa of scientific and technical cadres and on their ability to meet and exchange views. ARCSE should therefore encourage all kinds of useful meetings such as the organization of study tours, seminars, meetings etc. at the regional and subregional levels. This assistance should also be supported by the exchange of views and methods through meetings among technicians, scientists and industrialists in the form of trade fairs, exhibitions, etc.

The Training Unit will be co-ordinated by a Chief of Unit and will comprise three experts seconded from the solar, wind and biomass energy sections. Furthermore, it will use the three technicians of the Conference Section for the organization of meetings, etc., and a typist.

The composition and strength of this Unit are attached to this document as Annex VIII.

IV. CONCLUSIONS

This document was prepared by the ECA secretariat on the basis of the Constitution of the African Regional Centre for Solar Energy and of the document entitled "Les aspects organisationnels et operationnels liés aux activités d'un centre africain" (The organizational and operational aspects of the activities of an African Solar Energy Centre) prepared by Professor Djibril Fall of the Faculty of Science, University of Dakar, in December 1980.

In the organizational aspects of ARCSE it was indicated that the Centre would comprise the following bodies:

- The Council
- The Executive Board
- The Secretariat

The Secretariat could be headed by an Executive Director assisted by a Deputy Executive Director, a Chief Technical Adviser and by Directors or Chiefs of the following Units:

- Administration Unit
- Documentation and Information Unit
- Energy Strategy and Co-operation Unit
- Research and Applications Unit with Solar, Wind and Biomass Energy Sections
- Design, Manufacturing and Maintenance Unit
- Training Unit

The strength and composition of the secretariat of the Centre are attached to this document as Annexes IX and X respectively.

In its research and application activities, ARCSE could sign research and production contracts with national and subregional centres.

To make these activities most effective, ARCSE could invite consultants to undertake short missions and call on the services of accredited specialists.

Consultation among African scientists could be done within the framework of ARCSE with a view to strengthening co-operation among scientists, engineers, technicians and associations connected with solar energy.

The African Regional Centre for Solar Energy will provide assistance to member States in the search for the necessary funding sources for the realization of some solar projects.

ADMINISTRATION UNIT

(Composition and Strength)

	Senior Staff	Staff	Techn.	Clerk/Worker
Director of Administration	1			
Secretariat				
1 Secretary for the Unit		1		
1 Typist (bilingual)			1	
1 Typist				1
Sections				
(a) Personnel				
1 Chief of Personnel		1		
2 Clerks				2
(b) Finance				
1 Chief Accountant		1		
2 Accountants and Finance Officers				2
(c) Conferences				
2 Technicians			2	
6 Translators		6		
(d) General Services				
1 Chief of Services		1		
5 Technicians			5	
5 Workers				5
Total	1	10	8	10

DOCUMENTATION AND INFORMATION UNIT

(Composition and strength)

	Senior Staff	Officers	Techn.	Clerk/Worker
Chief of the Unit (Computer Engineer)	1			
Documentalists				3
Computer/Terminal Technician			1	
Clerks				3
Typists				3
Total	1		1	9

ENERGY STRATEGY AND COOPERATION UNIT

(Composition and strength)

	Senior Staff	Officers	Techn.	Clerk/Worker
Chief of Unit (Engineer or Physicist)	1			
Engineers specialised in the following:				
Solar Thermodynamics		1		
Photovoltaic		1		
Biomethane		1		
Wind Energy		1		
Economist			1	
Typist				1
Total	1	4	1	1

RESEARCH AND APPLICATIONS UNIT

A. SOLAR ENERGY SECTION

(Thermodynamics and Photovoltaic Sub-Sections)

(Composition and strength)

	Senior Staff	Staff	Techn.	Clerk/Worker
Director, acting also as Chief of Section	1			
Research and Development				
1 Chief Engineer		1		
2 Technicians			2	
3 Clerks				3
Industrial Application				
1 Engineer		1		
4 Technicians			4	
5 Clerks/method				5
Social Acceptance				
1 Technician			1	
1 Clerk				1
Total	1	2	7	9

RESEARCH AND APPLICATION UNIT

B. WIND ENERGY UNIT

(Composition and strength)

	Senior staff	Staff	Techn.	Clerk/Worker
Chief of Section	1			
Research/Development				
1 Engineer		1		
1 Technician			1	
1 Officer				1
Experimentation				
1 Engineer		1		
1 Technician			1	
3 Clerks/Workers				3
Total	1	2	2	4

RESEARCH AND APPLICATION UNIT

C. BIOMASS ENERGY SECTION

(Composition and strength)

	Senior Staff	Staff	Techn.	Clerk/Worker
Director of Section	1			
Research and Development				
1 Engineer		1		
2 Technicians			2	
3 Clerks				3
Design and Experimentation				
1 Engineer		1		
4 Technicians			4	
5 Clerks				5
Total	1	2	6	8

DESIGN, MANUFACTURING AND MAINTENANCE UNIT

(Composition and Strength)

	Senior Staff	Staff	Techn.	Clerk/Worker
Chief of Unit	1			
Planners		2		
Designers			4	
Engineers		2		
Technicians			7	
Workers				21
Total	1	4	11	21

TRAINING UNIT

(Composition and strength)

	Senior Staff	Staff	Techn.	Clerk/Worker
Chief of Unit	1			
Training Experts (technicians) from Solar, Wind and Biomass Energies Sections)				
Experts in the organization of meetings			3	
Typists				1
Total	1		3	1

TOTAL STRENGTH OF THE SECRETARIAT

(Summary)

	Directorate	Senr. Staff	Staff	Techn.	Clerk/Worker
General Directorate	2	1			
UNITS:					
Administration		1			
Secretariat			1		
Bilingual secretary				1	
Secretary					1
Sections:					
Personnel			1		2
Finances			1		2
Conference				2	
Translators			6		
General Service			1	5	5
Documentation and Information		1			
Documentalist					3
Computer/Terminal Technician				1	
Clerks					6
Energy Strategy and Co-operation		1	4	1	1
Research and Applications					
Sections					
(a) Solar Energy		1	2	7	9
(b) Wind Energy		1	2	2	4
(c) Biomass Energy		1	2	6	8
Design, Manufacturing and Maintenance		1	2	7	21
Planners, Studies			2	4	
Training		1		3	1
	2	9	24	39	63

GRAND TOTAL = 137

ST/ECA/NRD/E/2
Annex X

GENERAL ORGANIZATIONAL CHART OF THE AFRICAN REGIONAL CENTRE FOR SOLAR ENERGY